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Knowledge-based entrepreneurship in Estonia

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Contents

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Abstract

The importance of new firm creation in the post-Communist economies of East Central Europe (ECE) has been subject to extensive research. This paper focuses on an area of entrepreneurship which has received relatively little attention in the transition economy context but which is of particular importance for the modernization of the transition economies: knowledge-based entrepreneurship (KBE), or new firm creation in industries considered to be science-based or to use research and development (R&D) intensively. We begin by sketching the situation in Estonia's small and medium-sized business sector, then proceed to study the conditions for high-tech firm development in the country, with particular attention devoted to the development of Information and Communication Technologies (ICT), which have been of particular significance in the Estonian case, as well as the questions of finance and policy initiatives. We then turn to the analysis of a series of case studies of firms active in the areas of information technology, life sciences, and digital mapping and navigation technology. Among the issues treated are the resources and strategies involved in KBE in Estonia, the relationships (networks) of the firms in question and how they are used for knowledge acquisition, and barriers to innovation and development. In spite of a relative lack of government support, we find that overall Estonia appears to be one of the better locations for KBE in the ECE region, with rising R&D spending, a highly educated entrepreneurial class, and universities that have moved forward rapidly in the development of technology transfer support facilities. The firms studied here rely for much of their success on foreign markets; on the other hand, difficulties in internationalisation can be identified as one of the key bottlenecks for the development of Estonian KBE. In the area of business relationships and networks, academic partners dominate.

1. An overview of the economic development of Estonia

Estonia is a country located in the Northeastern Europe and belongs to the upper middle income group of countries with PPP based GDP per capita in 2004 around 12000 Euros (Eurostat, 2005). Since regaining independence Estonian economy has passed the process of economic, political and social transformation using textbook case macroeconomic reforms with the liberalisation of foreign trade, using currency board exchange rate system and implementing flat rate tax system. The period up to the late 1990s could be described mainly as the period of restructuring, which produced macroeconomic stabilisation, privatisation and rapid structural change. Productivity growth was quite high. Its major sources were the reallocation of production factors between sectors, within industries and the better organisation of business.

Within the last years the transition and restructuring paradigm was replaced by the concept of economic and social convergence to the EU average level. In order to present more detailed comparative view about the speed of convergence process of Estonia among the other accession countries Table 1 was constructed. It compares the income level (measured as GDP at PPP per capita) convergence process of the all new EU member states, Romania and Bulgaria between 1995 and 2004. The data for 2004 were preliminary and were taken from the forecasts of Eurostat and WIIW. The most rapid process of reducing gap between income levels with EU-15 was in this period in three Baltic countries – Estonia 16.4%, Latvia 14, 6 and Lithuania 13.3. Next group of countries were Hungary with 11.7% and Slovenia 11.2% of reduction of the gap with EU average. But since early 2000 the economic catching up process of Estonia and other Baltic countries has been very fast in comparison with other transition countries.

Table 1. The convergence process of accession countries toward EU-15 level

	Convergence level – GDP at PPP from EU average in % (EU 15=100)			**Speed of convergence (reduction of the GDP gap with EU in %)**
	1995	**2000**	**2004**	**1995-2004**
Slovenia	61.2	66.4	71.5	11.2
Czech	62.2	59.6	65.3	3.1
Hungary	44.9	48.8	56.6	11.7
Slovakia	40.3	43.8	49.3	9.0
Estonia	31.2	37.6	47.6	16.4
Lithuania	31.9	35.8	45.2	13.3
Poland	34.4	41.7	44.2	9.8

	Convergence level – GDP at PPP from EU average in % (EU 15=100)			Speed of convergence (reduction of the GDP gap with EU in %)
	1995	2000	2004	1995-2004
Latvia	26.2	31.5	40.8	14.6
Romania	27.9	23.1	31.2	3.3
Bulgaria	28.2	24.5	30.2	2.0

Source: own calculations using Eurostat and WIIW data

Since early 2000 the potential of growth from the structural reforms and resource reallocations became rather limited for sustainable future growth. The growth in early 2000 was supported by the rapid increase of domestic demand fuelled by the growth of bank loans to the private sector. On the other hand the openness of the Estonian economy has been beneficial to the growth of external competitiveness and export growth has been another important engine of economic growth after Russian crises in 1998. But the major factor of competitive advantage is still low production cost, mainly low labour costs. Within the last decade the growth process of labour costs has been strong and hence the labour costs based competitiveness has a self limiting character. Therefore it becomes an urgent necessity to think about the ways how to keep Estonian economy also long run competitive and innovating, accumulating new knowledge and technology and finding a high value added niche in the European and global division of labour.

Currently the Estonian economy is moving from the resource based to the investment driven growth stage. The major resource based sectors in the Estonian economy are forest sector (producing 25% of total industrial output), food and beverages (around 19% of industrial output) and construction materials production (around 5% of output). Starting from early 2000 the total investment propensity in Estonian has grown and the ratio of gross fixed capital formation to GDP has reached to the level around 30%, which was characteristic e.g. to the Japan by its investment driven stage of development.

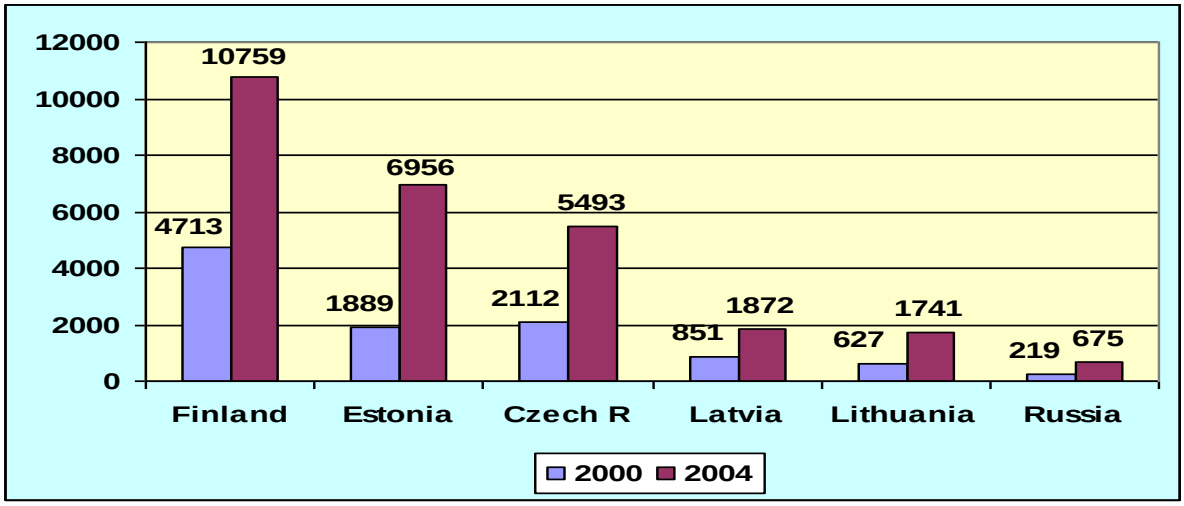
Table 2. Gross fixed capital formation in Estonia compared with other new members of EU and industrialised countries between 1994 and 2004 (% of GDP)

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
EU-15	**19.8**	**19.8**	**19.6**	**19.4**	**19.9**	**20.2**	**20.6**	**20.2**	**19.4**	**19.1**	**19.2**
Estonia	***26.8***	***25.9***	***26.7***	***28.1***	***29.6***	***24.9***	***25.4***	***26.5***	***28.5***	***30.2***	***29.5***
Latvia	14.9	15.2	18.3	18.8	27.3	25.2	26.5	27.0	26.4	25.5	25.7
Lithuania	23.1	21.4	21.4	23.0	24.2	22.2	18.8	20.2	20.4	20.8	21.1
Hungary	20.1	20.1	21.4	22.2	23.6	23.9	23.5	23.5	23.4	22.0	22.2
Poland			19.4	22.0	23.6	24.0	23.5	20.7	19.0	18.4	18.8
Slovenia	20.1	20.4	21.4	22.7	23.6	26.4	25.7	24.0	22.6	22.9	24.2
Ireland	16.5	17.5	19.1	20.8	22.4	23.9	24.2	23.5	22.1	22.3	22.4
Japan	28.3	27.8	28.4	28.1	26.9	26.3	26.3	25.8	24.2	23.8	23.8

Source: Eurostat, 2005

In general the major problem currently in Estonian economy is not the low investment propensity, but the efficient use of new investments. In this respect Estonia has oriented very much toward creating attractive investment climate in order to bring in foreign investors and expected that positive effects from FDI will help to improve the competitiveness of the whole economy. Estonia has been very successful and the per capita inward FDI stock in Estonia was in 2004 the biggest among the new EU member states. The EU enlargement has further increased interest of foreign investors to enter into Estonia and other Baltic states, but also inward investments into Finland have grown rather rapidly. Figure 1 describes the growth of inward foreign direct investments in Estonia comparing it with other Baltic states and Czech Republic, which is the most successful country to attract foreign direct investments among the Central European new EU members. The figure reveals that inward FDI stock per capita in Estonia was around 7000 USD per capita and has grown 3.7 times, in Czech Republic 2.5 and in Finland 2.3 times within period 2000 till 2004.

Figure 1. Inward foreign direct investments stock per capita in 2000 and 2004 (in USD, World Investment Report 2005)



The undertaking of FDI by multinational firms involves complex strategic decisions, based on considerations about ownership, location, and internalization. They take into account also many other factors like attractiveness of the investment climate (political, social, regulations, infrastructure), macroeconomic stability, proximity to the key markets, agglomeration economies and clearly production costs level. The growing interest of investors toward Estonia and the whole Baltic Sea region could be explained not only dynamic markets. According to the World Bank study “Doing Business in 2005” the Baltic Sea region offers some of the best regulatory environments in the world in which to do business. Finland and all three Baltic states are among the 30 economies in the world in terms of the report’s ease-

of-doing-business index. The region is one of the easiest places in the world to start a business, requiring only 6.2 procedures on average to register the new company. Along with the region's procedural simplicity comes relative speed and reduced expense. The Baltic Sea region as a whole grants its employers great flexibility in hiring and firing their workforce. Only firms in East Asian and Pacific countries enjoy greater ease in expanding, reducing and managing the workflow of their employees (World Bank, 2004).

But the inflow of foreign capital is currently still oriented toward reaping benefits from the relatively low labour costs. Therefore typical problems of transition country could be observed in Estonia:

1) structure of the economy dominated by the labour intensive sectors of production;
2) low value added intermediate products are dominating in Estonian exports
3) structural change of exports is going slowly
4) productivity level in all sectors is far below the EU-15 benchmarks
5) some labour intensive sectors are losing competitiveness already now (clothing, textile, furniture)
6) research and development base is narrow (particularly in private sector)

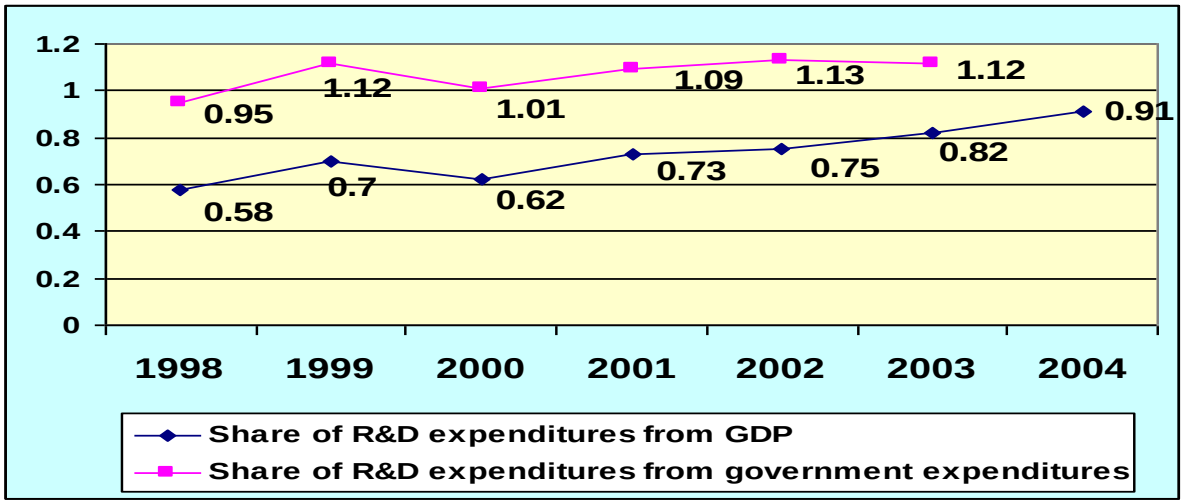
The competitiveness of the Estonian economy in short run is strong, but the situation could be rather complicated in the medium and long run. When the export competitiveness is based only on low labour cost rather than technological advantage, export expansion does not provide strong incentive for innovation and technical progress. This is supported by the recent research by P. Vahter, who discovered that export oriented firms in Estonia (both foreign owned and domestic) had lower labour productivity than non-export sectors (Vahter, 2004). Similar findings have also been made in China (Xiaolan Fu, 2005). In addition compared with non-export industries, export industries in China have much lower capital-labour ratios.

A. Havas has written about Hungary that "economic development can be maintained, or even accelerated, without indigenous R&D and innovation efforts in the short run thanks to foreign direct investment. Country opting for this 'development' path becomes not only overly dependent on foreign technologies, but would most likely to lose its attractiveness, too: at best becoming the 'dumping site' of outdated technologies, or even abandoned by foreign manufacturing firms altogether" (Havas, 2003). This evaluation fits perfectly also to describe the situation in Estonia. Only strong local knowledge base creates long term attractiveness of Estonia to the foreign investors. This could help to bring dynamic MNC into Estonia and use

their knowledge base in order to develop our economy. In general it means that a lot of efforts should be given to direct Estonia into innovation (or knowledge) driven growth stage.

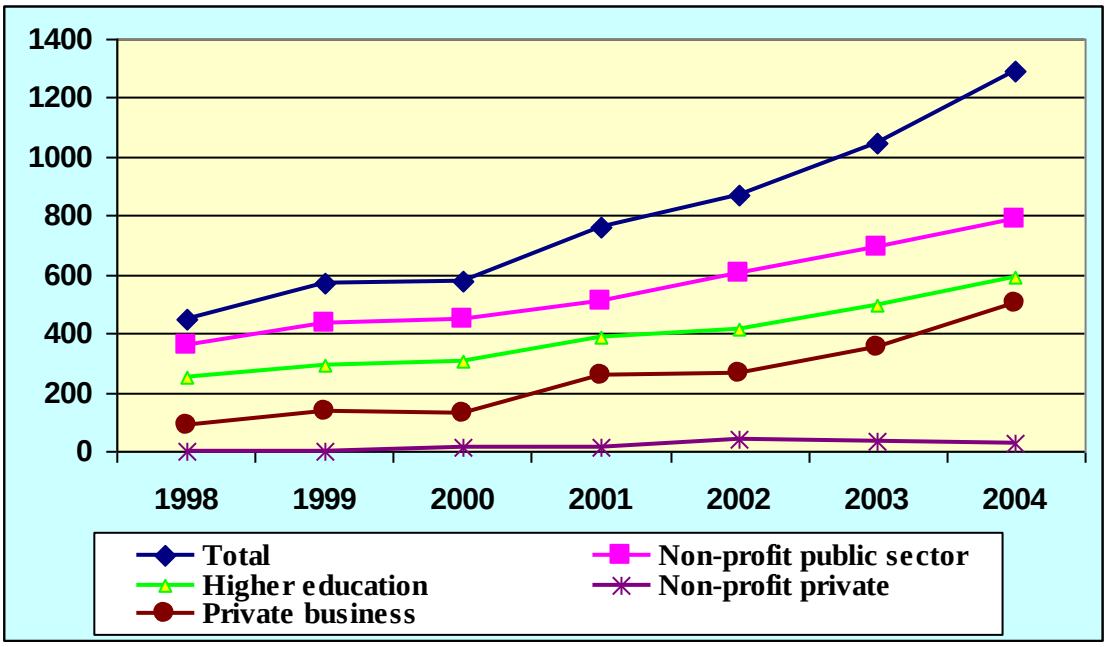
Unfortunately the current level of research and development (R&D) expenditures in Estonia is far below the level of neighbouring countries. In 2003 Sweden had the highest R&D intensity (4.27% of GDP), followed by Finland (3.51%), Denmark (2.60%) and Germany (2.50%). By 2003 the ratio in Estonia has reached to 0.83% of GDP, which is higher than in Poland (0.59%), Slovakia (0.57%), Latvia (0.39%), but still lower than in Slovenia (1.53%) or in Czech Republic (1.35%). Positive is the trend of growth in R&D expenditures in Estonia since 2000 and the planned target will be to reach 1.5% level in 2010 (see figure 2).

Figure 2. The share of R&D expenditures in GDP and government spending in Estonia, 1998-2004



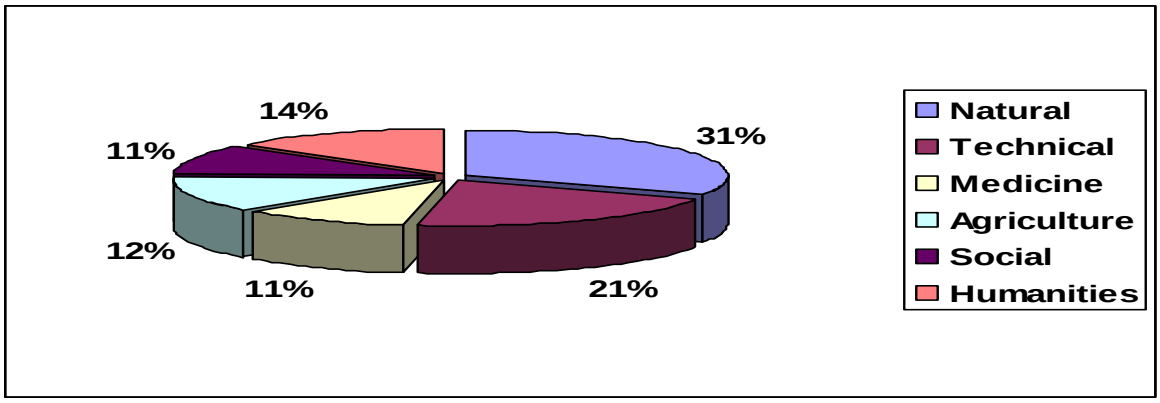
But currently the share of private business in the total R&D expenditures in Estonia is still very low and stands on around 30% of total expenditures within the last four years. Figure 3 shows the dynamics of Estonian R&D expenditures by different institutional sectors. It reveals that the private business R&D expenditures are growing rather quickly and since 2003 the growth rate is even higher than the growth of non-profit public sector (which includes all governmental R&D expenditures). It could be taken as the first positive signs in the behaviour of the private business sector.

Figure 3. Expenditures on R&D by different institutional sectors in millions of EEK per year



The structure of research and development funding from the Estonian non-profit public sector has been allocated in favour of natural and technical sciences. Figure 4 presents the distribution of public sector funding of research between different fields of science. The share of natural sciences is 31%, technical 21% and medicine 11%, which means that 54% of all R&D expenditures from government are supporting the generation of new businesses in those fields of science.

Figure 4. The structure of Estonian non-profit public sector research and development funding by fields of science in 2004 (in % of total)



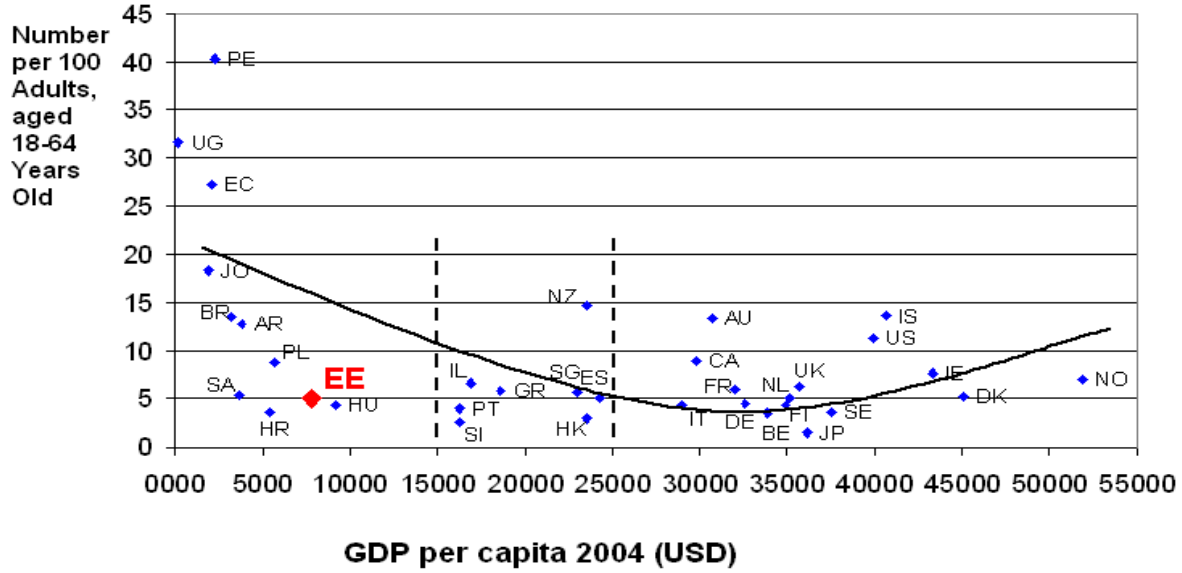
The current structure of public funding is favoured toward natural sciences and should potentially support the development of high technologies and therefore facilitate the growth of knowledge intensive industries: But the public funding is extremely in favour of supporting fundamental research and the share of applied and development and prototype stages of

funding is only around 10% of total. This is a major barrier of developing sectors using heavily high technologies.

1.1. Entrepreneurial activity among Estonian population and structure of firms

The general attitude of population toward entrepreneurship is internationally measured using methodologies of Global Entrepreneurship Monitor and Flash Eurobarometer 160. The Global Entrepreneurship Monitor (GEM) is an international research effort, launched in 1999 as an initiative of researchers from the London Business School and Babson College from Boston. The GEM project enables the establishment of the level of entrepreneurial activity of a country by calculating the Total Entrepreneurial Activity (TEA) Index, which expresses the ratio of the number of people per each 100 adults (between 18 and 64 years of age) who are trying to start their own business or are owners/managers in an active enterprise not older than 42 months. In November 2004 the Estonian Economic Research Institute carried out first time also survey according to the GEM principles. Figure 5 gives a comparative evaluation about the entrepreneurial activity in Estonia and other countries participating in GEM project. The Total Entrepreneurial Activity index in Estonia is low and close to several other new EU member states as well as old members (Finland, Sweden, Denmark). The level of subsistence entrepreneurship is low as well and reflects the advancements also in the level of income in Estonia. The position of Estonia is rather typical for a country with the upper middle income level.

Figure 5. Total Entrepreneurial Activity (TEA) Index in Estonia in 2004 compared with other countries participating in Global Entrepreneurship Monitor project

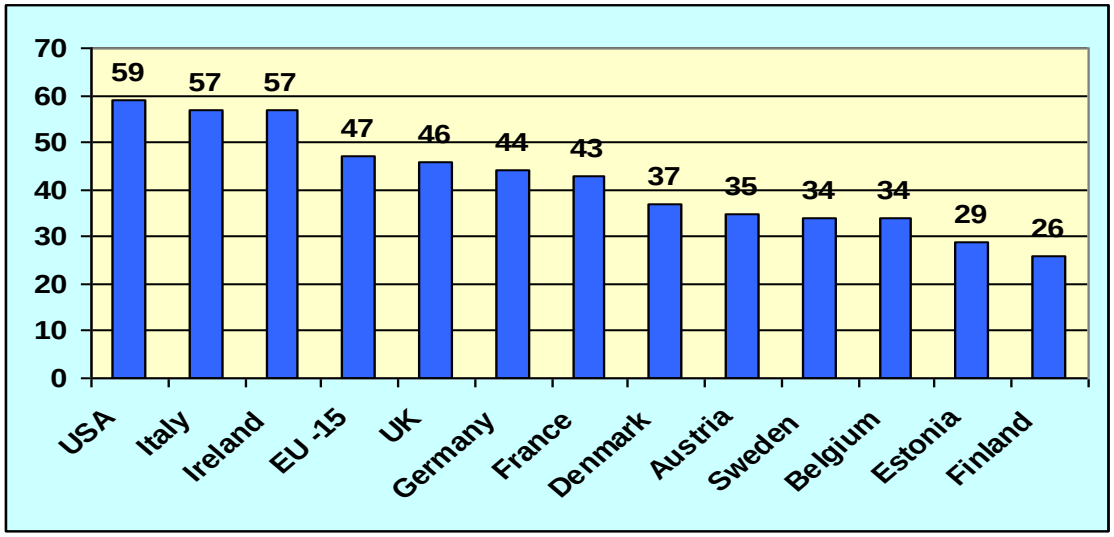


Source: Josing 2005

In general the population of Estonia is not highly interested to become an entrepreneur. The following figure is describing the results of the survey executed in November 2004 among 16-64 years old people in Estonia using the same methodology as Flash Eurobarometer 160.[1] Only 29% of answered persons in Estonia declared the preference to work as self employed persons (Josing 2005). It gave to Estonia the position at the very end of the list of countries presented in Figure 6. But it was interesting and promising that the educational level works clearly in favour of starting one's own business in Estonia.

Among the respondents with higher education 26% worked as self employed, among people with secondary education the share was 10% and among people with basic education only 3%.

Figure 6. The share of people with preference to work as self-employed person among the population 16-64 years old in EU-15 countries and Estonia



Source: Josing 2005

The positive linkage between higher education and preference to work as self employed could influence positively the future new business generation process in Estonia, as it is one of the countries with the highest share of people with higher education. Following Table 3 is presenting the share of persons (25-64 years) with completed higher education (university or equivalent) in Estonia and some EU member states in 2002.

[1] EOS Gallup Europe – FLASH EB No 146 "Entrepreneurship" (10- 23/09/2003) Report.

Table 3. Percentage of persons (25-64 years) with completed higher education (university or equivalent) in Estonia and some EU member states in 2002

	Percentage of persons (25-64 years) with completed higher education (university or equivalent), 2002		
	Total	**Women**	**Men**
EU25	**20.4**	**19.7**	**21.1**
EU15	**21.8**	**20.8**	**22.8**
Czech Republic	11.8	10.0	13.6
Estonia	29.7	*	*
Cyprus	*	*	*
Latvia	19.6	22.0	16.8
Lithuania	21.9	25.4	17.9
Hungary	14.1	14.5	13.7
Malta	8.8	7.4	11.1
Poland	12.2	13.7	10.6
Slovenia	14.8	16.5	*
Slovakia	10.8	11.0	10.6
US	**26.7**	**25.1**	**28.5**

* Data unreliable owing to small sample size
Source: Eurostat 2004.

There are about 90,000 business units including all types of firms plus self-employed entrepreneurs amongst the 1.4 million inhabitants in Estonia registered in 2005. Tallinn, the capital of Estonia and its surrounding Harju county dominate economic life of Estonia: more than half (52%) of Estonian businesses are registered there. The general distribution of businesses in Estonia, capital region and Southern Estonia by economic sectors in 2004 is presented in the Table 4. It reveals that the biggest number of firms are active in wholesale and retail trade (28.9% of total number of firms), followed by real estate and renting (18%), agriculture and forestry. Majority of companies in Estonia are relatively small, active in traditional or relatively labour intensive sectors.

Table 4. Structure of business units by economic sectors in Estonia, Tallinn region and Southern Estonia (in per cent of all units in 2004)

	Estonia	**Tallinn (capital) region**	**Southern Estonia**
Agriculture and forestry	14.5	2.3	28.9
Wholesale retail trade	28.9	34.8	24.5
Real estate, renting	18.1	24.8	12.4
Manufacturing	9.7	9.4	10.0
Transportation, communication	9.7	10.8	8.0
Construction	5.8	6.6	5.0
Hotels, restaurants	3.2	2.8	3.3
Health and social work	1.6	1.3	2.0
Other service activities	4.1	3.4	2.8
TOTAL	100	100	100

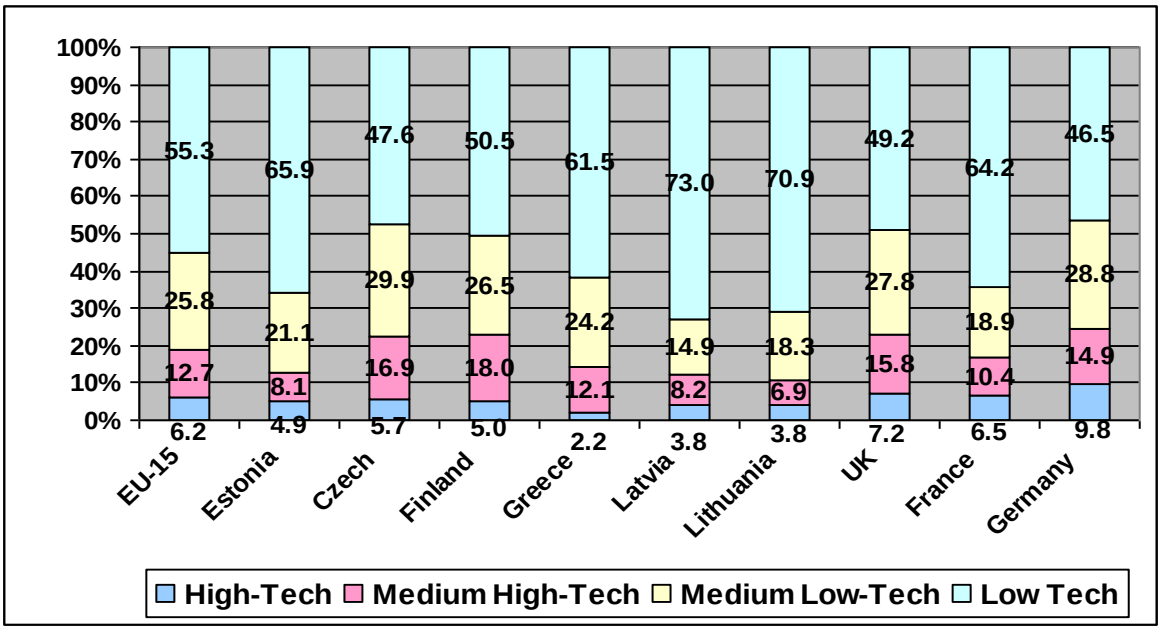
Source: calculated from Statistical Office of Estonia 2005

Unfortunately available statistical data does not allow precisely estimate the share of firms which operate in knowledge and technology-intensive fields. As an indirect measure could be

used OECD classification of industries into high, medium-high, medium-low and low technology and services divided into high-tech knowledge intensive, market knowledge intensive and market less knowledge intensive sectors (see detailed classification in Götzfried, 2005, p.7).

Using comparative data from the Eurostat database following figure was constructed, which compares the structure of firms in Estonia with other EU countries by the technology level. By the end of 2003 the total number of industrial firms in Estonia was 4398, of which 215 were in high tech, 357 medium- high tech, 927 in medium-low tech and 2899 in low tech industries. The share of firms from the high or medium-high technology branches of industry composed 13% of all industrial firms in Estonia. This is one of the lowest levels among the countries listed in Figure 7. Only two other Baltic countries – Latvia and Lithuania had also very low level of this type of firms. On the positive side were UK, Germany and also Czech Republic, which is particularly strong in medium high tech sector. In those countries almost a quarter of firms were in high or medium high tech industries.

Figure 7. The structure of firms by the technology level in Estonia and by some other EU members



Source: authors' own calculations based on Götzfried, 2005, p.7.

1.2. ICT sector development and diffusion into Estonian society

Estonia experienced explosive development of information and communication technology in the early 1990s. Estonian society was heavily inclined towards a fast acquisition of modern technologies, existed rather broad willingness to experiment with new solutions. The important facilitator of this process has been the closeness to the Scandinavian countries,

which are the frontrunners in ICT sector development in Europe. Currently Estonia has been acknowledged as the rapidly evolving information society.

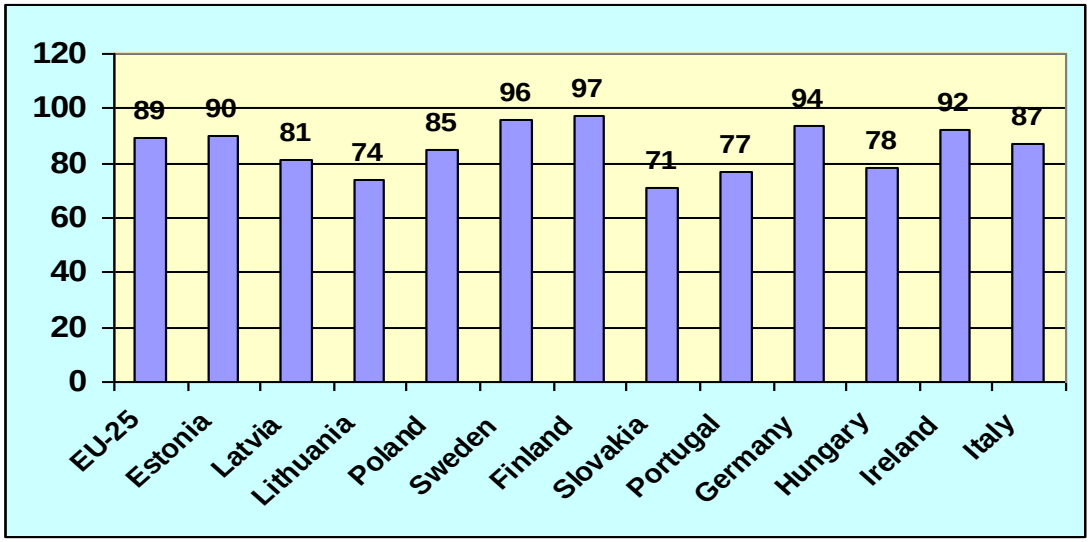
At the end of 2004 about 50% of the Estonian population were users of the Internet (http://www.ria.ee/). By February 2005 electronic Identification Cards (ID cards) had been issued to 46% of the population. Parking payment by mobile phone and e-banking are very popular. By the beginning of September 2005 around 95% of banking operations are carried out electronically with the number of Internet bank clients amounting to nearly 1.1 million out of a population of 1.35 million. In spring 2005 more than 70% of tax declarations were submitted using e-tax-declarations. In 2005 about 80% of the performers of state examinations received their results via SMS (for more information, see Estonian Informatics Centre, http://www.ria.ee/atp/).

Recent developments in the Estonian telecommunication market are characterised by the fast development of both telecommunications market and Estonian information society as a whole, which has produced a rapid increase in the number of telephone lines; proportionally faster mobile communication usage growth compared to the fixed networks; accessibility to modern telecommunication services and reduction of the prices; total liberalisation of the telecommunications market (expiration of the exclusive rights granted to Estonian Telecom) since January 1, 2001; promotion of technological development by the State through legislation (Cable Distribution Act, Telecommunications Act, Digital Signature Act; see more detailed analyses in Kalvet et al., 2002). In the beginning of 2005 there were 62.9 main phone lines per 100 households and the digitisation level of main lines was 82%. Mobile phone penetration rate was approximately 90%.[2]

The rapid uptake of novel technologies, enhanced wireless communication infrastructure, a high number of conventional telephone lines and Internet hosts has created a moderately favourable platform for building up appropriate forms of applications. The Internet penetration rate in the firms of EU member states is rather equal, but strong differences could be discovered in the level of use of Internet in order to fulfil different tasks by firms (see Figure 8). Around 90 per cent of Estonian firms had access to Internet by 2004, which is close to the EU-25 average level. On average, 89% of European enterprises with 10 or more employees have an Internet connection. The highest was the rate in the Nordic countries (Denmark and Finland 97%), and the lowest in Lithuania (80%), Portugal and Hungary (77%).

[2] Estonian Information Society in Facts and Figures (http://www.esis.ee/ist2004/12.html)

Figure 8. Access of firms to Internet in 2004 (% of all firms)



Source: Demunter 2005

More detailed information about the use of Internet by Estonian firms is presented in Table 5, which shows the rapid increase of the share of firms, which could use broadband connection. Table 5 reflects the wide variety of tasks carried out by Estonian firms using Internet. More than 60% of firms had used it for seeking information necessary for the firm from public sector web sites and also submitted firms-related documents to public sector agencies. One third of firms applied for licenses or permits or performed registration procedures related to the firm. More than 90% were very or rather satisfied with e-services provided by public authorities. It is indicating that the e-service providers have been rather successful in designing needed services and made them available not only to the big firms but also to the small and medium size firms.

Table 5. Use of Internet and ID card in Estonian enterprises

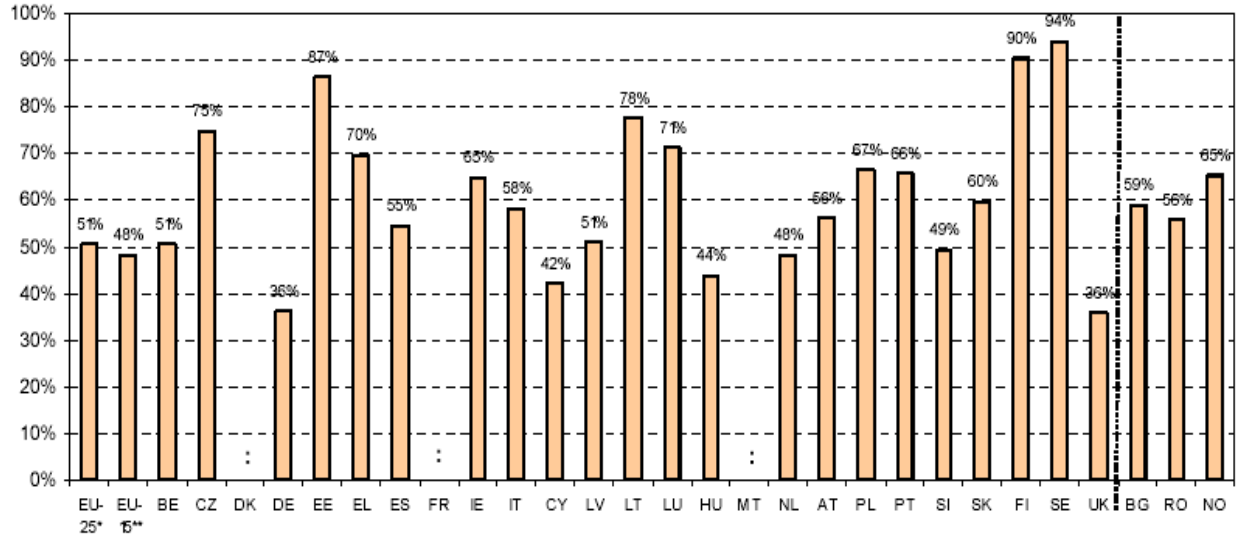
INDICATORS	2005	2004	2003
1. Internet connection in enterprises (% of enterprises with computers)			
enterprises with broadband connection	**86%**	83%	74%
enterprises with dial-up connection	**8%**	10%	21%
enterprises without Internet connection	**6%**	7%	5%
2. Enterprises with web site (% of enterprises with Internet connection)	**41%**	41%	36%
3. Use of e-services provided by public authorities (% of all enterprises)			
seeking information necessary for the enterprise from public sector web sites	**63%**		
submitting enterprise-related documents to public sector agencies	**60%**		
applying for licenses or permits and/or performing registration procedures related to the enterprise	**35%**		
do not know/have not used	**29%**		

INDICATORS	2005	2004	2003
Satisfaction with e-services provided by public authorities (% of enterprises having used public e-services)			
very satisfied	**22%**		
rather content than discontent	**71%**		
rather discontent than content	**5%**		
do not know	**2%**		
Use of ID card in enterprises (% of all enterprises) by purposes			
electronic identification of users	**2%**		
giving digital signature	**1%**		
for other forms of identification of employees (as a door card etc)	**1%**		
have not used the ID card in enterprise	**90%**		
do not know	**7%**		

Source: Facts about Estonia. Estonian Informatics Centre (http://www.ria.ee/atp)

The relative position of the Estonian firms with other EU countries regarding the interaction with public authorities will be given on the following figure, which shows the percentage of firms with Internet access having obtained information from public authorities' websites in 2004. Figure 9 reveals big differences - Finland and Sweden recorded percentages far above the EU average (90% and 94% respectively), closely followed by Estonia with 87%.

Figure 9. Percentage of firms with internet access having obtained information from public authorities websites in 2004



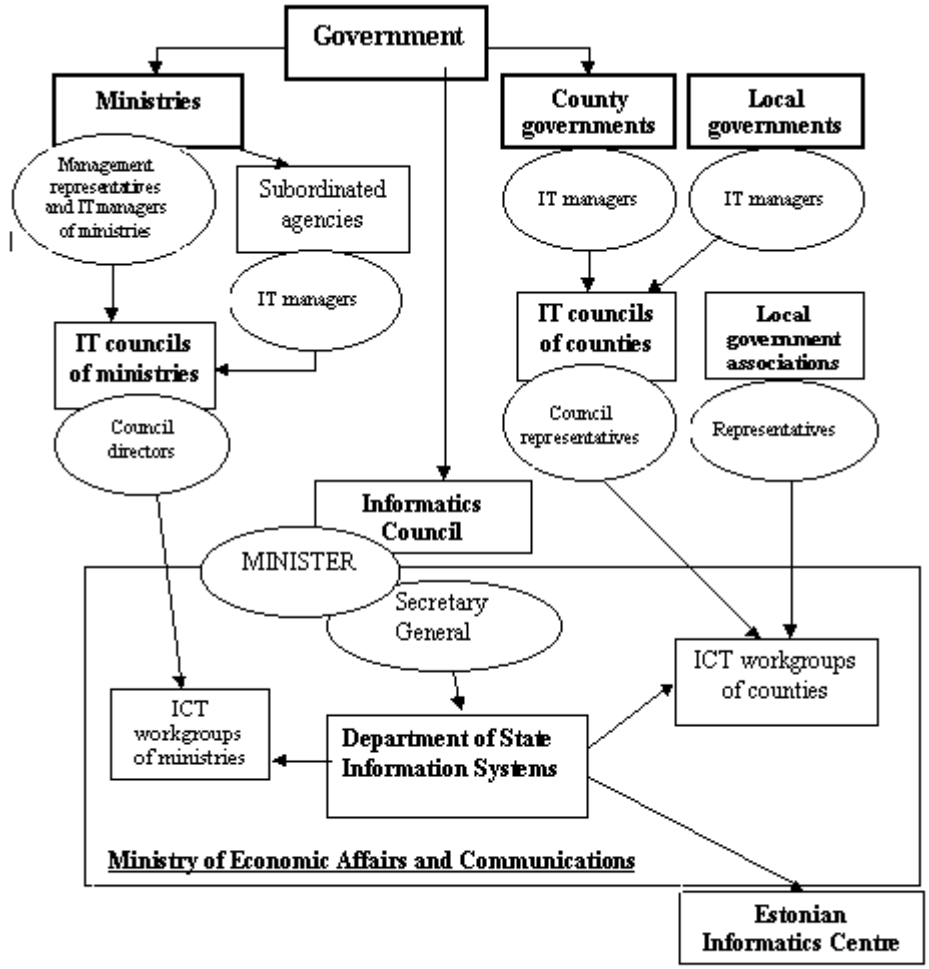
Source: Eurostat 2005

Among the countries with data available, Germany and the United Kingdom reported very low rates (36% of enterprises).

The positive development in Estonia in the field of use of ICT solutions by government sector has been supported by the E-Governance Academy. It is a non-profit organization founded for creation and transfer of knowledge concerning e-governance and e-democracy. E-governance Academy provides platform for analyzing and systematizing both international and domestic experience into forms of knowledge that can be transferred to those interested both at home and abroad. In summer 2002 the Estonian government, United Nations Development Program (UNDP) and the Open Society Institute (OSI) jointly set up a Regional e-Governance Centre in Estonia. The main aim of the training centre is to provide training in ICT coordination, organisation and usage for the public sector managers and specialists and representatives of the third sector of former Soviet republics, Central and Eastern Europe, and Asia. The training project offers practical information and experiences of Estonia, know-how of EU international experts and exchange of experiences of participants in the training.

On the negative side in the national innovation system of the ICT sector is the rather limited cooperation between the academic and business communities, while only a few institutions are engaged in creation of high added value. Only 35% of the ICT enterprises of Estonia admitted that they knew something about the existing scientific research establishments; only 9% of the companies had ever used professional assistance from research institutions. More than half of the poll respondents pointed out the overly academic approach of the universities and R&D institutions as the reason for their limited cooperation.
(http://www.esis.ee/ist2004/63.html)

Figure 10. Organisational structure of ICT management in Estonia



Organisational structure of ICT management in Estonia

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Source: http://www.esis.ee/ist2004/63.html

1.3. Evaluation of the current innovation policy incentives

The results of the analyses of the structure of firms in Estonia by their technology intensity also supports idea, that Estonian economy is just in the beginning of the process of moving into knowledge based development stage and this process needs facilitation from the well functioning national innovation system, which should create appropriate innovative capacity widely in the society.

The knowledge- or innovation-driven stage of economic development realises itself through economy wide improvements in the absorptive capacity of economic agents to search, diffuse and utilise knowledge created outside of Estonia and combine this knowledge with the local research competence in order to create sophisticated solutions, which finally ends in productivity improvements in the economy. But reaching the innovation-driven stage needs systematic support from the state in the form of proper industrial and innovation policies.

Estonia has been an interesting case of the country, which has since regaining its independence moved ahead without having defined its innovation policy and one could define Estonian innovation policy as 'no-policy policy' (term proposed by Kalvet et al., 2002). The major improvement in the policy level thinking started since late 1990s, when two important documents about the Estonian innovation policy were prepared: The Estonian State Innovation Programme (approved in June 1998) and the National Development Plan for the years 2000–2002 (1999), but unfortunately none of these were actually implemented. The major reason was reluctance of allocation of resources to the fulfilling objectives defined in those plans (see more detailed analyses in Tiits et al., 2003). It was also the period of establishing major institutional elements in the Estonian national system of innovation.

Nonetheless, Estonia has defined its research and development (R&D) strategy in a document, "Knowledge-based Estonia: Estonian Research and Development Strategy 2002–2006", passed by Estonian parliament end of 2001. This document positioned Estonia as a place where creation of new knowledge, application of skills and knowledge and development of human resources are the sources of the competitiveness of the economy. The strategy defined three key areas of R&D activities in Estonia: information society technologies, biomedicine and material technologies. The document established a very ambitious goal – to increase the share of R&D expenditures to 1.5% of the GDP by 2006. Positive was that the new strategy document clearly emphasises that state has a role to tackle with different market and other failures and should act as an investor, catalyst and regulator. On the other hand, due to its political nature, the document is full of value statements and does not present detailed action plan, although it also acutely emphasises the need to strengthen innovation policy implementation structures. The latter remains crucial, as without properly functioning public policy instruments, the document, although trying to create noteworthy public discussion and to increase general awareness, remains just a document (see Kalvet, 2001, pp. 34-35).

The most recent strategy document in Estonia was passed by the end of 2004 and was called Estonian Success 2014 (Eesti Edu 2014). The strategic goals set in this document are even more ambitious than in previous documents as e.g. it foresees to double Estonian GDP by 2014, increase productivity by 80%, and increase employment rate up to the 70% of labour age population.

Knowledge-based Estonia as a strategy document reflects the widespread opinion about innovation policy makers tend to believe – namely, that high tech industries are synonymous

with the high value added, high wages and rapid growth. The major focus should be on the intention to create new high technology industries or at least support production and commercialization of domestic research and development. But the attempt to allocate majority of resources into creation of high tech sector should not be executed on the expense of the support to the competitiveness of the much bigger part of so called non-high tech of the economy, which is producing decisive share of production and employs majority of people. There exists a threat to create a dual economy with low wage, low productivity traditional sector producing majority of employment and GDP and a small high-tech sector that is relatively isolated from the rest of the economy. Here certain balance should exist between two groups of economic sectors. The Finnish and Swedish examples in the wood and paper industry are indicating how a rich natural resource endowment was used as the basement on which to build competitiveness and wealth, based on specialization in knowledge intensive, high value added activities. These examples are indicating that the competitiveness will be achieved by using high tech technologies in different segments of mature medium and low tech industries.

Another misunderstanding is about the mechanistic relationship between increased R&D spending and higher per capita GDP. The proposed rapid increase of R&D expenditures up to the proposed level of 1.5% from GDP in 2006 and 3% in 2013 without significant reforms in the structure of R&D spending would be waste of resources. Experience of Finland, Ireland and Korea revealed that increased R&D spending and GDP per capita goes together with the growing share of private sector R&D. It means that private sector should be involved into this process, but it means that innovation policy should not be limited to promoting only R&D. Recent innovation surveys indicated that only small fraction of Estonian firms innovate and most of those innovate by importing capital equipment rather than by conducting basic research themselves or purchasing research services from Estonian or foreign research institutions (Kurik et al., 2002). It indicates that Estonian firms are often not on the current technology frontier and the growth of their productivity and competitiveness does not require the implementation of the cutting edge R&D. Consequently a broader focus is needed, with a stress on various dimensions of technology development. The role of non R&D aspect of technology development could be extremely important as local firms need the policy which supports the major tasks of technology upgrading - the ability to acquire technology developed outside the country, and the managerial, organizational and technical capacity to utilize more advanced technology.

Much less attention has been given in Estonia to the development of the system of absorption and diffusion of knowledge produced in the world. Estonia is so small country that

even in case of increasing its relative R&D expenditures to the level of world leading countries the domestic research potential is extremely limited. It could not alone solve the problems of upgrading the technological capability and productivity of Estonian main economic sectors. Certainly commercialisation of knowledge from research done in Estonia is important, but this is clearly limited and the majority of the economically relevant knowledge for Estonian firms to compete internationally will be still produced elsewhere.

Consequently the success of Estonian economy depends heavily on the capability and willingness of firms to search, adapt, utilise knowledge produced outside Estonia. We need to have skills – to understand the knowledge, be able to use it and to adapt it for creating new knowledge. But information about the innovations and technologies is not free and widely available, particularly for SMEs. Estonian firms are in general small and therefore mechanism about the awareness of available innovations and access to the relevant channels of communication should be organised. This system should help to avoid situation that firms are not able to identify which technologies they need and may therefore use inappropriate technologies. But in the Estonian context the technology transfer is really a problem of learning. The technology transfer requires next to the financial resources also managerial expertise.

Hence the future of Estonian society depends heavily about the success to implement learning (technical, managerial etc.) in organisations. Unfortunately learning is not an automatic process, but certain motivation to enter the learning cycle must exist. From one side the competitive pressure from the world market should indicate the need for learning. But on the other hand governmental policy should support creation of various learning networks (regional, sectoral clusters) with the aim to increase the capacities of the firms. It reflects the current trends in the innovation policy where the earlier models of science push or market pull interpretations of the innovation model have been further developed and innovation as the social process model is used instead. The importance of social networks in the innovation process is acknowledged. In conclusion the human capital is the major production factor of Estonia and therefore Estonian economy and its innovation system is competitive only when it could utilise the existing and improve the knowledge base in the society.

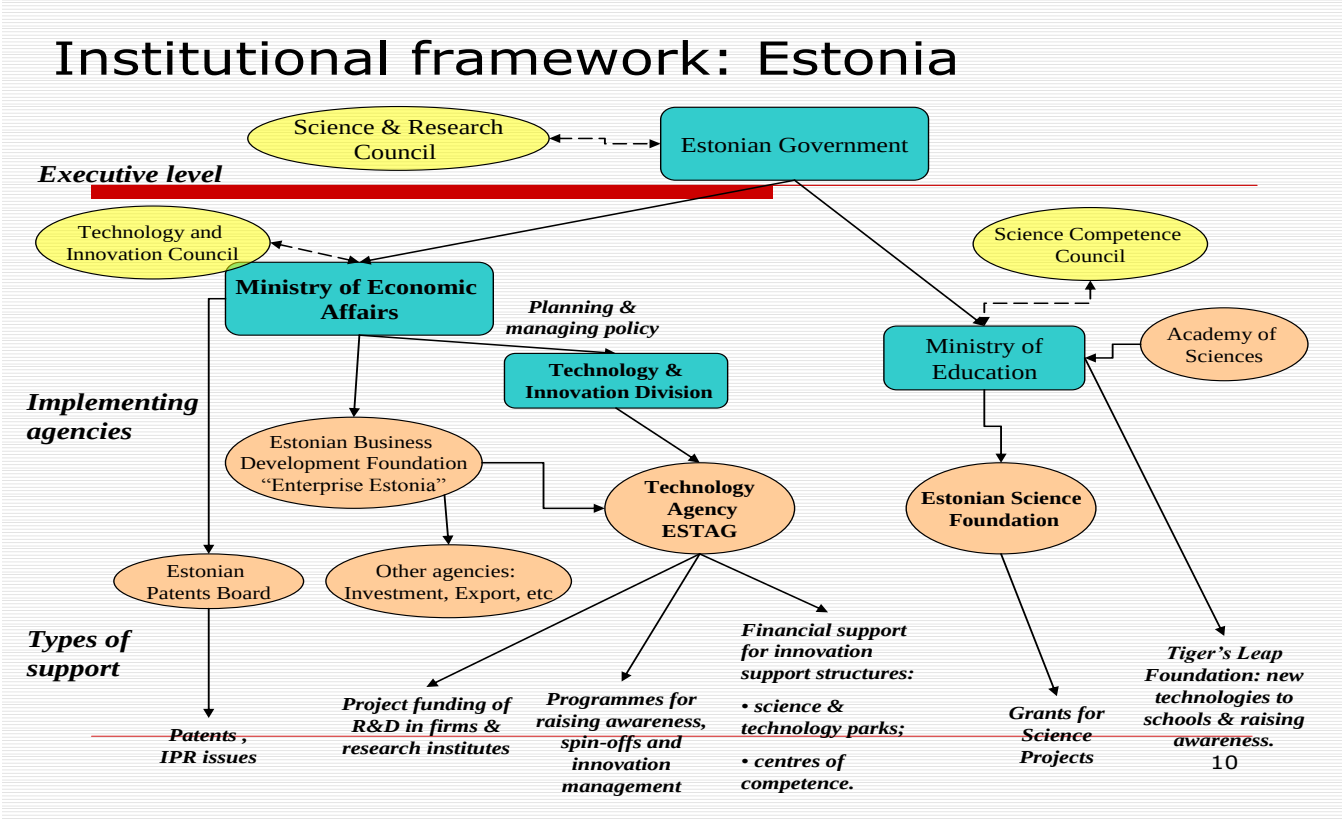
1.4. Institutional framework for innovation policy

The institutional framework of the national innovation system is presented in Figure 11. The major elements of the system are Science and Research Council at the Estonian

Government, Science Competence Council at the Ministry of Education and Technology and Innovation Division in the Ministry of Communication and Economic Affairs.

In addition important role is given to the Estonian Science Foundation (ETF), established on July 1990 by Estonian Government as an expert research-funding organisation. Its main goal is to support the most promising research initiatives in all fields of basic and applied research. The ETF uses state budget money to award research grants to individuals and research groups on a competitive basis. The 2005 ETF research grant budget was 91 million EEK (about 5.8 million euros), which represents about one-fifth of the total of the Estonian government's research funding (http://www.etf.ee/index.php?setlang=eng).

Figure 11. Estonian Innovation System – Institutional Framework

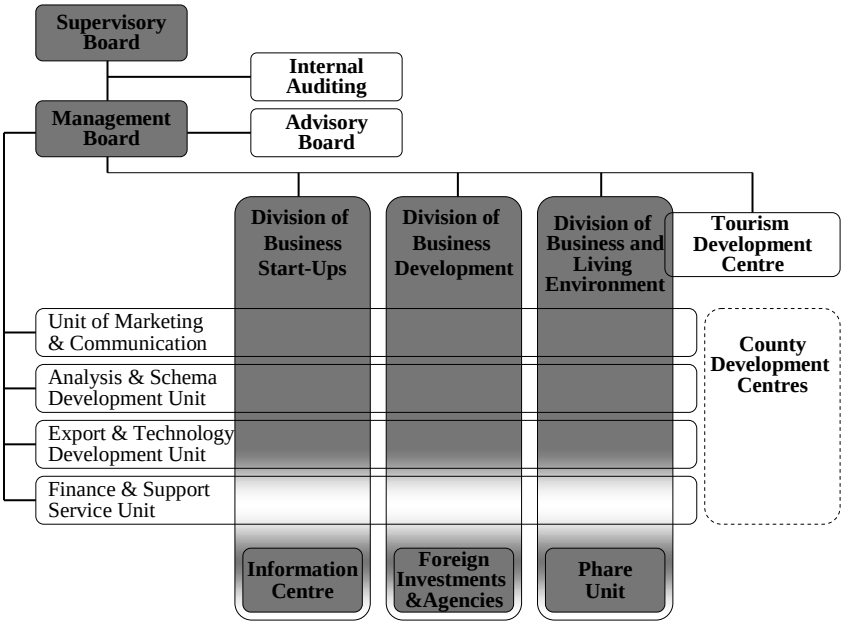


Source: Reid 2002

The majority of elements of Estonian innovation system represented in Figure 11 are in place currently as well without any change. The only major change occurred in the organisational structure of Enterprise Estonia, which is the major institution supporting entrepreneurship and innovative activities in Estonia created in 2000 by Estonian Ministry of Economic Affairs (http://www.eas.ee/?id=1271). Structure of Enterprise Estonia based on agencies specialising by the special fields of competence – Technology Agency, Investment Agency, Export Agency etc. – was since 2003 reorganised into three divisions: the Business Start-Up

Division, the Business Development Division and the Business and Living Environment Division (see Figure 12).

Figure 12. The organisational structure of Enterprise Estonia



After joining the EU, Enterprise Estonia has taken the role of the implementation unit of EU Structural Funds and supervises allocation of resources to the enhancement of the competitiveness of Estonian enterprises in foreign markets, the inclusion of foreign direct investments, the development of tourism exports and indigenous tourism, the elaboration of technological and innovative products and services, the development of Estonian enterprises and the entrepreneurial environment and the enhancement of general entrepreneurial awareness.

In addition to the Enterprise Estonia the export activities of Estonian firms are supported also by the Credit and Export Guarantee Fund (KredEx), which was founded in 2001 by the Ministry of Economic Affairs and Communications with the aim to improve financing of small enterprises in Estonia, decrease export-related credit risks and enable people to build and renovate their homes (http://www.kredex.ee/?id=1534). It consists currently of following departments: Export and Enterprise; Housing; Risk Management; Finance and IT, Marketing and Product development.

Next important institution is Archimedes Foundation, which works as an independent body established by the Estonian government in 1997 with the objective to coordinate and

implement different EU programmes and projects in the field of training, education, research, technological development and innovation. Within Archimedes exists the *European Union Innovation Centre* with the aim to enhance the participation of Estonian research, commercial and other organisations in EU research and technological development programmes. More specific tasks are to disseminate information about EU programmes to organisations; give consultations for project proposal writers; implement specific projects so as to enhance the innovation capacity of Estonian society; develop Estonian Research Information System ERIS (http://www.irc.ee/Eng/index2.htm).

In August 2001 the Enterprise Estonia Foundation, Tallinn University of Technology (TUT), Ministry of Economic Affairs, Ministry of Education, and the City of Tallinn established jointly Tallinn Technology Park (Tehnopol) with the objective to establish and develop the innovation-supporting business environment which encourages the transfer of knowledge and technologies between R&D institutions, companies and markets. In order to achieve the objective Tehnopol offers to the knowledge-intensive companies the quality physical infrastructure together with value-adding business development services and favourable synergetic effects resulting from specific business associations (http://www.tehnopol.ee/?id=1085).

Another relevant institution supporting innovative activities is the Tartu University Institute of Technology: It is a research and development institution, which was established in June 2001 and aims to create a new cultural environment to facilitate the generation of new technological solutions. The mission of the Institute of Technology is: to create a basis for high-tech economy in Estonia through R&D activities; to increase the competitiveness of Estonian companies by facilitating and actively participating in the innovation process promoting development of Estonian intellectual capital. The emphasis is on training scientists and current and future entrepreneurs with a technological profile. The R&D centres are being established in the following areas: material and chemical; biomedical; environmental and information technologies (http://www.tuit.ut.ee/132574).

In Tartu, second biggest town of Estonia, Tartu Science Park (TSP) was established in 1992 as the first organization in Estonia set up with clearly stated intention to support innovation. TSP is linked to the Estonian biggest university – University of Tartu. The latter produces more than a half of the Estonian R&D. Hence, the main goal of TSP is to provide variety of services needed in the process of R&D commercialization. Currently, there are 26 companies residing on approx 3000 m^2 of office, laboratory and production space (http://park.tartu.ee/eng/?p=1).

In Tartu as the major centre of research in biotechnology works also Tartu Biotechnology Park with the aim to create a favourable and developing environment for the promotion of biotechnological entrepreneurship in Estonia. TBP offers infrastructure and related services for biotechnological development activities and entrepreneurship. To promote entrepreneurship TBP prepares and implements strategic development projects and diversifies various services offered to biotechnology companies. The Tartu Biotechnology Park offers services to foreign biotechnology companies who wish to start operations in Estonia and to Estonian companies who intend to establish branches abroad, helping them in the incorporation of companies and finding personnel and cooperation partners (http://www.biopark.ee/en/front.html).

Estonian Biotechnology Association (EBIO) plays an important role in the promotion new business creation and support of existing companies. It is a non-profit organisation, which represents biotechnology companies and academic institutions in Estonia. The goal of EBIO is to help its members in finding better opportunities inside and outside the country through networking and partnering events to create better opportunities for developing the biotechnology sector in Estonia (http://www.biotech.ee/index_eng.php?act=2).

A similar function is assigned in the field of information technology to the Estonian Association of Information Technology and Telecommunications (officially abbreviated to ITL) is a voluntary organisation, whose primary objective is to unite the Estonian information technology and telecommunications companies, to promote their co-operation in Estonia's development towards information society, to represent and protect the interests of its member companies and to express their common positions. Main activities of the association include popularisation of information and communication technology (ICT), promotion of vocational education and amendment of legislation. As of the August 1st 2005 ITL has all in all 36 members (http://www.itl.ee/english/general/index.asp).

1.5. The environment for technologically innovative entrepreneurship in Estonia

Education and research. Out of numerous Estonian institutions for higher education, the two largest universities – Tartu University and Tallinn University of Technology – play the most important role in technology-related R&D and education. Universities' core research competencies include not only traditional, but also novel scientific areas like biotechnology, nanotechnology, and material science. Over the last decade these universities have established special units to support scientists in commercializing research outcomes (e.g.

Science Parks, Technology Transfer Offices). Nevertheless, the activity of these entities are often criticized for the lack of relevant experts involved, inadequate financing or insufficient cooperation with local businesses. Even though the two mentioned universities are relatively strong in basic research, their commercialization competencies are not yet fully developed, and the training for entrepreneurship is insufficiently integrated in study curriculum.

Governmental support to high-tech businesses. Financed from the state budget and EU structural funds, each of the 15 counties in Estonia has a business development office. The offices offer traditional business support services, but are relatively poor in helping highly specialized technology companies in raising funds, getting overview of the market or establishing international networks. Enterprise Estonia – country's largest business support organisation – has several initiatives to support all (not only high-tech) companies. Among the support measures are start-up grants (10,000 € max), promotion of quality management, export plan preparation grants, export markets information, training and consultancy grants (up to 6,400 €), loan, leasing and export guarantees etc. For example, high-tech companies can apply for a 45-75% refund of company's R&D, or applied research costs. Enterprise Estonia also develops countrywide R&D infrastructure, supports activities of technology parks, incubators, and competence centres financed by EU structural funds (www.eas.ee).

Funding and venture capital

A) Public funds. The largest source of research, technological development and innovation (RTDI) support - targeted financing and research grants for RTDI - is provided through the budget of the Ministry of Education and Research, and managed by this ministry as well as Estonian Science Foundation. There are also multiple national research and development programmes directed by various ministries (Estonian Science Fund and Ministry of Education and Research – research grants and allocations), who independently manage the allocation of the resources. Second largest funding stream is administered by Enterprise Estonia. The evaluation of activities have shown that persons involved in funding procedures often do not have the necessary expertise, and there is lack of clarity of assessment criteria, institutions involved are highly fragmented and conduct overlapping projects. Overall amounts of RTDI financing in Estonia are not sufficient to develop knowledge-based economy (Nedeva & Georghiou 2003). Since 2003 Ministry of Economic Affairs and Communication has developed idea about state and state-private seed capital for early-stage financing of KBEs (Nedeva & Georghiou 2003, Eesti riiklik riskikapitali fond 2004) which is reaching necessary decisions in 2006.

B) Private Funds. Even though there are several foreign venture funds operating on Estonian market, private equity (PE) investor funds as well as single investors (business angels) are reluctant to support local RTDI business projects due to the high risks (Nedeva & Georghiou 2003, Eesti riiklik riskikapitali fond 2004).

The history of Estonian venture capital (VC) is quite short. The basis for private venture funding raised as the result of sale of own successful companies by entrepreneurs established these businesses, for example: Hansapank – banking sector, in 1998/1999; Sylvester AS – timber sector, in 2003 (http://www.raamatupidaja.ee/index.php/343;5180); etc. Mainly these entrepreneurs have invested afterward their money into new businesses of the same sector they were experienced. That means, although, 15 years after starting private business there is not the big number of grown in Estonia investors having competency in knowledge-based entrepreneurship.

The VC funds active in Estonia are mostly representing Scandinavian or other western countries (see Annex). BaltCap Management is the leading private equity investor in the Baltic States (Estonia, Latvia and Lithuania) providing equity capital for growth-oriented companies (as rule, not in start-up phase). Since 1995 BaltCap has invested over EUR 40 million in over 30 different companies and currently manages EUR 90 million in committed funds (http://www.baltcap.com/). The portfolio of investments includes the following knowledge-based companies:

- Koolitööd AS (E-School): Software (Estonia)
- EGeen International Corp.: Clinical research organisation (USA, Estonia)
- SIA ZetcomVirtual: Mobile Network Operator (Latvia)
- UAB ProTraining Academy: IT training (Lithuania)
- SIA Hanzas Elektronika: Electronics contract manufacturer (Latvia)

The most successful technology business investment project has been MicroLink and its subsidiary SAF, which became listed on Stock Exchange of Riga, Latvia. The company develops and produces digital microwave radiolinks used by telecom operators as an alternative to fibre and copper cables to provide data and voice communications. Founded in 1999, it has grown an average of 108% per year, making it one of the fastest-growing technology enterprises in the new EU member countries (http://www.microlink.com).

The case of Allan Martinson is one of the good examples of native Estonian VC. After the sale of the MicroLink, Martinson, one of its founders, joined with foreign investment company

Trigon Capital to create the new VC business Martinson Trigon Venture Partners in 2005 (http://www.martinsontrigon.com/ourteam/allanmartinson/).

A well-known success story of VC investing in Estonian KBE is Skype, the internet telephony technology company, which was financed by foreign investors and sold to eBay for 4.1 billion US dollars in 2005. Skype's technology is based on software created by four Estonians – Ahti Heinla, Priit Kasesalu, Jaan Tallin, and Toivo Annus – and commercialised by Scandinavian team Niklas Zennström and Janus Friis (Kaio 2005, Kivi & Martinjonis 2004).

Kristjan Kalda, the previous chairman of MicroLink and the partner of BaltCap Management, described Estonia in an interview with the authors as a moderate economic environment for VC / PE attraction in knowledge-based business. The main part of investments is channeled into growing companies and very seldom into start-ups. He agreed that the attractiveness for VC / PE can be enhanced by governmental support measures and establishing bigger businesses in the region.

2. CASE STUDIES

2.1. Description of the sample

Six companies have been studied. Being spin-offs from the University of Tartu, the companies have operated in high-tech industry for about 6-15 years. Most of the entrepreneurs have scientific background, their business ideas are based on their professional expertise. For the entrepreneurial scientists, described here, this business experience was the first one.

Company A

The company operates in biotechnology field. It was founded in the late 90-s by two professors – one from local and one foreign universities, and a master student working at the Technology Transfer Office at the University of Tartu. By the year 2005, the turnover of the company has exceeded 700 000 EUR, whereas 95% of the sales came in from Western Europe and USA. The sales of the first operating year were around 65 000 EUR.

The initiative to start business belongs to professor from Estonian University, who has developed the technology and wished to commercialize his professional knowledge and

become independent from the university. By the time of founding the company, the professor was in his forties and had an extensive managerial experience, although not from the business field. Professor has done studies in research centres in USA and Europe, and administrated activities of local medical and research centres.

Company B

Four middle-aged scientists from Tartu University, who did not have business experience before, founded this biomedical company in late 90-s. The company was started to exploit business opportunity in the field of molecular diagnostics in Estonian market. The founders were very experienced in biotechnology field, doing laboratory research at the University. In the company founded they were mostly responsible for technology development. To commercialize results from technology developed at the University's laboratories, the finance consultant was employed, who later became a managing director of the company. During the first years of operation the turnover of the company was approximately 100,000 EUR, which is expected to grow almost 7 times by the end of the year 2005.

Company C

Established in 1999, the company's vision was to commercialize an invention – a medical device, developed by the university's scientist, aged about 60 at that time. The product was a result of over thirty years of research. The scientist has graduated from the University of Tartu, where he has also obtained a PhD degree. The managerial experience of a founder results mainly from his experience when managing research units at the university, in addition the founder has also briefly worked in a factory as an engineer-constructor. The motivation to establish a company comes from scientist's wish to commercialize the idea developed over his PhD and postdoctoral research. Over the first years, the company did not generate any sales, but in 2004, as the product was prepared for the market, the sales reached 320,000 EUR.

Company D

Founded in late 90-s, this information technology company offers IT maintenance, sells computer hardware and software, and creates web pages. Two founders of the company graduated from the University of Tartu. Both were in their late 20-s and did not have business experience previously. The motivation behind starting a business was earning money using IT competencies to fill the market gap. The person responsible for the product development has a Master degree in science education, and currently is a PhD student at the University of Tartu, Faculty of Biology and Geography. The managing director of a company is expected

to obtain Master Degree in Entrepreneurship and Technology Management soon. After five years of operation, the turnover of the company reached 200,000 EUR.

Company E

The company was established in late 80-s by a group of 3 scientists at the Institute of Physics of the Estonian Academy of Sciences. The scientists used the first possible opportunity to found a company; earlier establishment of a private company was not legally possible in Estonia. The company develops and produces accessories for lasers, lasers of different types and laser based instruments for science, medical applications, entertainment and electronic industry. From the beginning there were three founders. The leader was a person with doctoral degree in his late 40-s, who was earlier invited to Estonia from Russian research centre, completed the start-up team two laboratory researchers. The main reasons for establishing the company were manager's need for self-realisation, favourable conditions in the target market and wish to become independent from the University. Since the establishment, the annual sales growth was 10-20%, exceeding 1 million EUR in 2005.

Company F

Founded in 1990, the company operates in the following high-tech markets: geographical information systems, mapping, and mobile positioning. Established by 3 specialists in geography, the company initially had a family-business character: key positions were occupied by parents and their two adult sons. Later one of the sons with university degree took the leadership in company development, bringing venture capital to the company and going through the merger with a foreign corporation. By now the entrepreneur-manager has re-purchased the company which employs 60 people, focusing on entering new markets and developing R&D-intensive products and services. During the year 2005 the turnover of the company exceeded 1.6 million EUR.

2.2. Resources

Finance

Pre-venture phase. Over this phase, developing technology for future products and services, the entrepreneurs gained necessary funds from the following sources:

- Own capital (companies A, B, D, F)
- Research grants from USSR universities (C, E)
- Tartu University financing (C, E)
- Estonian Government grants, Innovation Fund (C).

Example: Company C. Prior start up, in the 1970-1986, the entrepreneur had numerous cooperation projects with USSR Universities. Projects financed by USSR Universities enabled entrepreneurial scientist to do the research and improve the characteristics of the future product. As the USSR collapsed in 1991 and contract work was no more possible between the universities, the entrepreneur applied for funds from the Estonian Innovation Fund to continue with product design and development. The sum raised through the fund amounted to 30 000 EUR. The financial support of the local university was rather in terms of physical assets (labs); the amounts of direct financial support from the University were insignificant.

Start-up phase. As the entrepreneurs reached the phase of registering the enterprise, the financing structure has slightly changed:

- Own capital (A, D, E, F)
- Estonian Government grants, Innovation Fund (A, C, F)
- Sales (prepaid) from the first clients (B, E)
- Bank loan (C).

Example: Company A. From the beginning, the company looked for financing from the venture capital funds in Estonia, but being a small, risky high-tech company it had little chance in raising money through the venture funds. To establishing the company, the managers of the company contributed altogether 6,500 EUR. Shortly after establishment, jointly with association for biotechnology, the company applied for and received financial support from Estonian Government. The support measure was a mixture of grant and loan on favourable terms, the total sum amounted to the 450 000 EUR.

Further business development phase. During the operation years the companies used the following sources:

- Estonian venture capital funds (A, C, D)
- Government grants and EU structural funds (B, C, E, F)
- Loan (A, B)
- Foreign venture capital funds (A, F).

Example: Company F. Oriented on aggressive growth, the company has tried multiple sources for financing. It not only raised private capital from around 30 persons, and also used venture capital – almost 30% of company belonged to the venture fund. After the first ten years of operation the company sold its shares to Finnish-based company for 4 mln EUR. Two years later the company bought its shares back, since the parent company went bankrupt. Additionally the company participates in EU FP6 project.

Employees

Over the pre-venture phase, most of described technology and business ideas were developed by 1-3 scientists at Tartu University. At the start-up period, four of the companies grew relatively fast (A, B, D, F), having employed 5-10 people, whilst two other companies' staff (C, D) consisted only of managers and 1-2 part-time employees. Most people, employed over the first operating years were recruited from Tartu University. These people were usually highly professional in the area of operations management, however they lacked business orientation and marketing skills.

Except for company D, which provided tailor-made IT services, the managers of the companies had outstanding scientific knowledge of the field, having connections to research institutions abroad and having overview of potential market locally.

Developing their companies, managers continued recruiting, employing up to 25 people in the following years, the positions were for example: researchers, lab technicians, administrators and marketing managers. Quite serious personnel problem was regarding marketing employees: there is shortage of professionals in a narrow technology field. Companies also had contracts with university laboratories technicians and researchers to perform project-based tasks. People from abroad are usually only involved as advisors, short-term consultants.

Example: Company D. When established, the company had 2 employees who were the founders. The company did not have an official office until 2002. In 2002 two founders of the company (and the only employees) decided to move to Tartu Science Park. The major reason was the favourable price of premises available at the Science Park and benefits from Park's help in establishing contacts in Estonia. Operating at the Science Park the company started to grow, employing additionally 5 people in 2-year period. Most of new employees were at first the trainees invited from the Tartu Vocational Centre. The two founders of the company are now responsible for general managing, product development, and finding new customers through personal contacts. Both managers have higher education. The person

responsible for the product development has a Master degree in science education, and currently is a PhD student at the University of Tartu, Faculty of Biology and Geography. The contacts at the Faculty have been helpful in gaining several clients, for example in the field of biotechnology business. The managing director is expected to obtain Master Degree in Entrepreneurship and Technology Management in 2006.

R&D

The research is mainly done locally, for example, in cooperation with scientific staff at Tartu University. Most of the founders of the studied companies are researchers who are highly professional in the scientific field being the basis for a business. Thus researchers have a good overview of international research in relevant fields as well as they screen major relevant trends. Several companies have had a short-term research experiments with institutions from abroad (clinics, research centres, large companies).

Research-intensive companies (A, B, E, F) have filed patents (Estonia, US, Germany, Japan). The decision favouring patent filing in the mentioned foreign countries stems from the large size of potential market for the companies as well as companies (yet superficial) business experience there.

Example: Company B. Established in 1999 by four scientists from Tartu University, this spin-off company started offering molecular diagnostics on the Estonian market. In the beginning, three business lines were run: molecular diagnostic, proteomics, and gene therapy. Molecular diagnostic was the greatest cash-generator for the company; the development of this area began by 1994 at the Tartu University in cooperation with clinical doctors. The other two fields needed greater investments and involved higher risks, requiring high initial investments. The company invested heavily in R&D work at the University labs in Tartu. People involved had strong technology know-how in the field. Initially the international cooperation in R&D was rather limited. Later however, the company conducted several research experiments with a number of Finnish and Swedish clients. Over the last years joint projects are running with clinics and research institutes in Canada, Italy and Germany. First patent was submitted to Estonian Patent Office under the principles of the Patent Cooperation Treaty (PCT) in 2001, in 2004 the company applied for US national patent based on the same priority. In the year 2005 the company B employed 26 persons: 15 laboratory researchers, and 11 administrative personnel. The majority of them come from the University of Tartu, which facilitates relationship with the university's scientists.

2.3. Strategies

Over the first few operation years most companies did not have a clear strategy for business development; most strategic decisions were rather spontaneous, incremental. Even though the companies generally had business plans, prepared when applying for finance (grants, venture capital, loans), entrepreneurs at the beginning had no objective or quantitative overview of market potential, target groups and future plans.

At the beginning most of companies focused on R&D, but also on finding finance and testing markets. Four companies who already had a product started by selling on the local market or the markets of their research partners (research centres in Europe and US). Pricing strategies were developed over negotiations with particular clients; employment strategy followed the volume of orders and the needs of clients.

For the future, most companies plan only moderate employment of research staff and are going to refocus their target market, setting clear priorities. Continuously, the companies search for new applications of the technologies and try to increase the value-added of their products and services. As most companies are very much interested in foreign markets, companies develop their web-pages to be client-friendly and look for more contacts abroad (Canada, Finland, Germany, Saudi Arabia, Sweden, UK, US).

One of most successful companies among the sample members (F) has created its own global market strategy based on a subcontracting and alliance relationship with global leading mobile network supplier Ericsson.

Several companies acknowledged having difficulties with managerial aspects of the business development. It was challenging to manage highly educated staff and to understand structure of a market.

Example: Company F. Started in 1989, the company was initially focused in cartography, preparing and printing maps on request, as well as for retailers and wholesalers. Shortly after establishment the managers have decided to modernize the company employing the latest technologies in cartography, digitalizing products and entering new business fields: mobile positioning and software-based geographical information systems. The objective was to achieve a high growth and go beyond local market. The company went though several rounds of financing: venture capital, government grants, mergers, EU FP6 Programme. Having started on the local market with traditional maps, the company in 2005 offers mobile

positioning services globally (being the biggest supplier of this service for Ericsson), in the courtiers starting from Sweden and finishing with Saudi Arabia, India, and Romania.

2.4. Relationships

Before the companies were officially registered, the most important relations entrepreneurs had were of academic nature – contacts with researchers and lab technicians in the University of Tartu and abroad (research institutes in ex-USSR, Finland). These contacts helped developing and testing products. Two companies (B, C) had contacts with institutions oriented on application research partners, e.g. clinics.

After establishment, the networks of companies started to enlarge. In terms of contacts with scientific institutions, the companies began to cooperate with local research centres (e.g. Estonian Bio Centre) and research institutes abroad. As for networking in non-science field, Table 6 describes those networking organisations that helped companies supporting business infrastructure.

Table 6. Networking of the case-companies – non-scientific collaboration

Institution	Function of the relationship
Tartu University Patent Office	Patenting, legal advice
Tartu University Office of Technology Transfer	Patenting, legal advice, preparing business plan, consulting in finance
Tartu Science Park	Establishing contacts with potential clients, marketing, using premises
Distributors, dealers in the foreign markets	Finding potential customers, selling products
Venture capitalists	Raising funds, consultancy in marketing

Example: Company E. Since the establishment and until the collapse of the Soviet Union, the major partners for the company were the clients in USSR. The founder of the company (originally exchange scientist from Moscow university) had good connections with research institutes in Russia and evaluated market conditions as very favourable at that time. The independence of Estonia caused replacement of client base with customers from Western Europe. The manager have benefited when using research facilities at the University of Tartu and communicating with the University's scientists. The company have several projects with local companies, designing and manufacturing electronic devices for them. According to the opinion of the manager, University's technology transfer office has not been very helpful because it lacks employees, who could quickly and skilfully offer consulting in the specific technological field. Also the programs of Estonian business support agency had relatively low

value for the company, because it is difficult for a small company to fulfill necessary criteria when applying for grants.

2.5. Partners in relationships

As stated previously companies have numerous relations in scientific and business spheres. None of the companies, either oriented on domestic or foreign market, has extensive relations with Estonian businesses, other than clients.

Notably, the cooperation with clients is often a relation, not a single contact to place and fulfil the order. The studied spin-offs offer mainly customized solutions (except for company C with its single product), thus close cooperation is needed to satisfy client's needs. The first relations with customers were often made due to the personal contacts of entrepreneurs, scientific researchers at the companies.

Companies, especially A, B and E had several attempts approaching foreign companies through e-mails, telephone, relevant fairs, and making on-spot presentation. Only very seldom the contacts resulted in agreements, leading to gaining a customer. Companies A and D, which have already had their experience selling experience in the EU market, started recently searching for and using reselling services, distributors and dealers. Some companies already have distributor agreements in Lithuania and Germany. Company F operating in geographical information system market was especially successful establishing relations with two large companies: one partner helped the company selling high-technology products, whereas the other facilitated development of a new technology.

Most intensive cooperation of the companies involved in this study has been done on research level with organizations in Estonia and abroad. Joining the forces the organizations did basic research, developed applications of scientific achievements and tested products or services. The list of countries whose organizations have been involved in joint research with studied companies includes Finland, Lithuania, Germany, Russia, Sweden, US.

The impact of government structures to develop the relation has been moderate. However, the effort of Tartu Science Park, Technology Institute and business support agency (EAS) were recognised by the entrepreneurs as positive and improving.

Marketing. At the beginning most of spin-offs lacked marketing skills, thus close cooperation with consultants was needed. Virtually all companies used marketing consulting from public

or private organizations. Two companies had at first part-time marketing consultant, then employing the consultant for the full-time job. Biotechnology company B eventually appointed marketing consultant for a position of managing director.

Company D has also cooperated with local vocational school to prepare new employees for the company, and invited students for internship. The results of such cooperation are very positive, because enabled smooth introduction of new employees into the company.

2.6. Support system and barriers to development

University

Back to 1999, when most of studied companies were started, the support at the university (technology transfer office) was evaluated as minimal; the situation in recent years has improved significantly, the range of services varying from consulting on IPR issues to preparing applications for funds.

Financing development

According to the opinions of surveyed managers, local venture capitalists are mainly interested in large enterprises or business with low risk, for example in the forest industry. The network of business angels is not large, and not oriented on financing biotechnology business because of high risks in comparison to other business opportunities, too long pay-off period and investors' lack of expertise in the field. Thus government grants and EU structural funds are seen as more accessible for the studied companies. However, the bureaucratic paperwork accompanying usage of state grants seem to upset entrepreneurs. The drawback of using venture funds and investors' money is in the opinion of entrepreneurs the necessity to share at least some decision-making powers with investors when making management decisions.

Internationalization

When establishing contacts abroad, the companies' managers experienced difficulties in adjusting to regional business cultures and defining target customer group. It would have been useful for the companies to have more information on potential clients than just the information from web pages of potential partners. The product of the company is highly customized, thus the companies usually interested in establishing close relations with their clients. It is rather difficult to initiate this kind of relation outside well-known home market. Even taking part in relevant fairs only rarely brought new customers.

Governmental business support

The Enterprise Estonia (business support agency) support has unfortunately limited value-added for knowledge-based small companies specialized in a narrow field. First of all, most of Enterprise Estonia's programs in the 1990-s were oriented at larger companies with stable market and stable turnover. The companies that do not spend much on marketing and cannot ensure high ratio of self-financing had almost no suitable programs to apply for. Secondly, Enterprise Estonia has a generalist consulting profile and does not have competent employees to provide specific information on specific high-technology industry in Europe.

3. Conclusions

The Estonian economy has passed the process of economic, political and social transformation using extremely liberal approach toward economic policy instruments and followed the principle of minimum governmental intervention (liberalisation of foreign trade, using currency board exchange rate system and implementing flat rate tax system). Accordingly Estonia is also an interesting case of a country that has moved ahead without having defined its innovation policy; indeed, one could define Estonian innovation policy as 'no-policy policy' until late 1990s.

In general the liberal approach followed by several governments of Estonia has been successful. The competitiveness of the Estonian economy in short run is strong, but the situation could be rather complicated in the medium and long run. During last decade Estonia has oriented very much toward creating attractive investment climate in order to bring in foreign investors and it was expected that positive effects from FDI will help to improve the competitiveness of the whole economy. But this policy has its limits, since if the export competitiveness is based only on low labour cost rather than technological advantage, export expansion does not provide strong incentive for innovation and technical progress. In the medium and long run the following weaknesses of the Estonian economy may create serious concern:

1) structure of the economy dominated by the labour intensive sectors of production;
2) low value added intermediate products are dominating in Estonian exports
3) structural change of exports is going slowly

4) productivity level in all sectors is far below the EU-15 benchmarks
5) labour intensive sectors are losing their competitiveness (clothing, textile, furniture)
6) research and development base is narrow (particularly in private sector)
7) the share of firms from the high or medium-high technology branches of industry is low.
8) the Total Entrepreneurial Activity index in Estonia is low.

The results of the analyses of the structure of firms in Estonia by their technology intensity also supports the idea that the Estonian economy is just in the beginning of the process of moving into knowledge based development stage and this process needs facilitation from the well functioning national innovation system, which should create appropriate innovative capacity widely in the society.

Therefore at least on the level of different economic policy documents during last couple of years was accepted the need to move toward knowledge based economy. In this respect was important the document “Knowledge-based Estonia. Estonian Research and Development Strategy 2002–2006”, in which Estonia defined its research and development (R&D) strategy. But unfortunately the current economic policy instruments are still too much out of balance in favour of supporting research and development activities, which mainly means funding of fundamental research in universities.

Recent innovation surveys indicated that only a small fraction of Estonian firms innovate and most of those innovate by importing capital equipment rather than by conducting basic research themselves or purchasing research services from Estonian or foreign research institutions. It reflects that Estonian firms are often not on the current technology frontier and the growth of their productivity and competitiveness does not require the implementation of cutting edge R&D.

Consequently a broader focus is needed, with a stress on various dimensions of technology development. The role of non R&D aspect of technology development could be extremely important as local firms need the policy which supports the major tasks of technology upgrading - the ability to acquire technology developed outside the country, and the managerial, organizational and technical capacity to utilize more advanced technology. Consequently the success of Estonian economy depends heavily on the capability and willingness of firms to search, adapt, utilise knowledge produced outside Estonia. This process will require certain skills – to understand the knowledge, be able to use it and to

adapt it for creating new knowledge. The investments into this area are extremely low and should be supported.

Another weakness is the poorly developed system of funding new knowledge intensive firms. A governmental system of funding early stage activities does not exist. Local venture capitalists are mainly interested in large enterprises or business with low risk, for example in the forest industry. The network of business angels is not large, and not oriented on financing of high technology businesses because of high risks in comparison to other business opportunities, too long pay-off period and investors' lack of expertise in the field.

The major business support organisation Enterprise Estonia has during last years created several initiatives to support all (not only high-tech) companies. Among the support measures are start-up grants (10,000 € max), promotion of quality management, export plan preparation grants, export markets information, training and consultancy grants (up to 6,400 €), loan, leasing and export guarantees etc.

Among other Enterprise Estonia instruments it is possible also for high-tech companies to apply for a 45-75% refund of company's R&D expenditures or applied research costs. Unfortunately up to now the support of growing knowledge intensive firms in the fields of biotechnology or information technology is very low on the stage of applied research and product development. The major funding is on the fundamental research level only provided from the Ministry of Education and Research budget and Estonian Science Foundation. The major problem with Enterprise Estonia is in its generalist consulting profile and lack of sufficient number of competent employees to provide specific information on specific high-technology industry.

After joining with EU relatively rapid adjustments started to occur in the policy making of Estonia in the field of business support mechanisms and creation innovation policy instruments. Funding available from the EU structural funds allowed to launch several new instruments of business support, but here is needed more careful use of experts to evaluate the effectiveness of their use. Within the current year is planned to start with the Estonian Development Fund – government fund initiated to support technology intensive and high risk business projects. It may be a very good start of the new stage in systematic creation of national business support and innovation system.

Annex

Venture capitalists in Estonia

Baltcap – A. Le Coq (sold 2000), EMV (1997), Teede REV-2 (2003), Microlink, Ecometal, Videoplanet (2004), Vipex, Thom Tehnika
Askembla – Tallegg, Tallinna Külmhoone, Aeroc, Eesti Eine, Microlink, TechData
LHV Ventures – CV Online, IT Meedia, Starman, BCS Itera, Osta.ee, One
Alta Capital – Klementi, Teede REV-2, Legendijuhtimise AS (Kuressaare Georg Ots SPA), Nybit, HEA 5 Ehitus
NG Investeeringud – Eesti Raudtee, Tallinna Kaubamaja, Balbiino, Liviko, Kitman, Sikupilli Keskus, Rocca al Mare Kaubanduskeskus, Norma (1999)
BSEF – EGeen, Askala, Asper Biotech, ETS Nord, PAL-Klaas, Remarks- R, Respo haagised, Semetron, Unitedmedia, Valnes
Hanseatic Capital (BalAEF, mezzanine) – Tallinna Masinatehas, Ortodontiakeskus, Stora Enso Packaging Warehouse, Eskaro, Sunorek
Amber Trust – Tallink, Vettel
Intergate (corporate) – Webmedia, E-Insurance, City24
Martinson Trigon Venture Partners
Rainer Nõlvak – Docobo, Celecure

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